Ozonation of Air for Ventilation

By A. I. Brown
Assistant Professor of Mechanical Engineering

What is the element in the ocean breezes and in the air on the mountain side that is so beneficial to the invalid and so delightful to all? Such is the question that has been asked time and time again by those interested in the problems of ventilation.

For many years it was supposed that the lower content of carbon dioxide in the air far from cities was the beneficial factor, but later experiments have shown beyond question that man experiences no ill effects in breathing air containing vastly more carbon dioxide gas than even that which is present in the most poorly ventilated rooms. Some have claimed the water vapor content of air determined its value, and yet the air of the arid mountain regions has more often appeared to be conducive to good health than the more humid atmosphere of the sea shore. Again, our attention has been called to the fact that if our body temperature changes by some three or four degrees from normal we are put to bed and if it increases seven or eight degrees we are put in our coffins, and the conclusion has been drawn that we are greatly affected by the wet-bulb temperature of the air as influencing our body temperatures. In this connection, within the past year a paper presented by O. W. Armspach before the American Society of Heating and Ventilating Engineers has shown an interesting relationship between the average wet-bulb air temperature and the death rate in the various sections of the United States.

Although much progress has been made, the problem of proper air conditioning has not been solved to our satisfaction, but at this time our attention is being directed with unusual interest to the claim of some that ozone is the substance of greatest value in conditioning air.

We are all, no doubt, acquainted with the odor of ozone which is detected in the atmosphere after a severe discharge of lightning or which is present in the neighborhood of high-voltage electrical machinery when in operation, even though we may not have recognized that odor as belonging to ozone. The discovery of ozone by the physicist Schoenbein in 1839 was brought about by the observation that the odor attending the decomposition of water into hydrogen and oxygen was similar to that present in the air after an electrical storm. Schoebein at first thought he had discovered a new element, but in consequence of later researches was forced to recognize ozone as a peculiar condition of oxygen in which it is endowed with special properties. It was observed that ozone would rapidly oxidize moist filings of the common metals, and bleach most vegetable colors, and its general characteristics as an energetic oxidizing agent were soon well known. It was found possible to detect its presence in pure country air by the change in color which it produced on paper steeped in iodide of potassium, and its absence from air, due to its power of combining readily with animal matter or other impurities, was considered as an indication of the presence of malaria in the atmosphere of the location in which such observations were made.

In more recent years many researches have been carried on, particularly in Europe, investigating the value of ozone as an oxidizing and a deodorizing agent, and in consequence of rather extensive medical researches much controversy has arisen concerning its physiological effects.

The value of ozone as an oxidizing agent is recognized in the use to which it is being put in sterilizing drinking water. Some European cities with populations of two hundred thousand or more, are daily sterilizing their entire supply of drinking water by the introduction of ozone, and our own Government Public Health Service has put itself on record as acknowledging this to be one of the best and most practicable methods of water purification.

The remarkable ability of ozone to counteract or mask objectionable odors has been repeatedly demonstrated, and ozone-producing apparatus has been found to be of great value in relieving the offensive odors accompanying many industrial and chemical processes such as the tanning of hides and the manufacture of glues. The odors from banana oil or other drying agents, the odors from restaurant kitchens and toilets and "crowd odors" in poorly-ventilated theaters and subways are now commonly counteracted by the installation of ozone-producing machines or "ozonators" as they are called. It may be of interest to note that the physiologist draws a distinction between the destroying and the masking of odors, and points out that the masking of an odor gives no proof of its destruction, for it has been shown that two odors can neutralize each other, as when ammonia is introduced into one nostril and acetic acid into the other in the proper proportions, which results in the sensation of no odor.

If the value of ozone lay only in its ability to counteract odors we would still find it of use in ventilation, but the chief interest at the present time is in its physiological effects.

In early medical researches, two obstacles in the way of investigating the effects of ozone were the difficulty of producing it free from the oxides of nitrogen, and the inaccuracy in measuring its concentration in air. It is possible that many of the early findings were unreliable on these accounts, but by the year 1910 or thereabouts, improvements in the design of ozone-producing apparatus assured the production of pure ozone. The researches on the physiological influences of ozone carried on in the laboratory of the London Hospital Medical College in 1911 and published by Leonard Hill and Martin Flack are therefore not open to the criticism of the earlier investigations along the same line.

Hill and Flack confirmed the conclusions of Schwarzenbach, of Barlow, and of Schultz that relatively strong concentrations of ozone in air caused irritation and oedema of the lungs and even death; although they concluded that the strong characteristic odor of ozone in concentrations greater than one part per million parts of air and the irritations set up should afford ample warning and prevent one's exposing himself unintentionally to a dangerous concentration. But Hill and Flack further observed no ill effects when the concentration of ozone was something less than one part per million parts of

air; in fact, they suggested a possible beneficial effect from breathing ozone in such weak concentration as to cause a mild irritation of the respiratory tract, thereby inducing a better circulation of blood and tissue lymph in the lungs. In reviewing previous investigations of the subject, they called attention to Schultz's belief that when ozone in strong concentration was breathed it passed into the blood and secondarily injured the lung, but they further noted that Bohr and Maar overthrew this supposition by the ingenious device of making one lung in both cold and warm-blooded animals breathe ozonized air while the other lung breathed normal air. They found this lung remained normal while the ozonized lung became inflamed.

As a result of the work of Hill and Flack and of certain French medical authorities, various theories relating to the action of ozone on the oxyhaemoglobin of the blood have been advanced, resulting in considerable disagreement among those conversant with this phase of the subject, but the greatest interest has now shifted from the laboratory of the physiologist to the domaine of the public-school health officer and the heating and ventilating engineer.

It has become apparent to the engineer in these days of high fuel cost, that a great saving, possibly of fifty per cent, will result if the air used in ventilating a building can be purified by the use of ozone and recirculated to the heater, thereby saving the heat that otherwise would be needed to increase the temperature of outdoor air to that of the indoor air. This feature, in addition to the universal desire to improve air for breathing, accounts for the installation within the past few years of a considerable number of ozone-producing machines.

Some of the most notable installations have been made in the public schools of St. Louis under the direction of E. S. Hallett, chief engineer of the St. Louis Board of Education, who has reported some of his observations in a paper presented at the January, 1920, meeting of the American Society of Heating and Ventilating Engineers.

The first installation in the St. Louis schools was made in one of the down-town schools which was attended largely by children of foreign parents who knew little of the use of soap and water, and who were said to follow the practice of sewing their children up for the winter. The odors of garlic and such foods prevailed in the class rooms and ventilation was so poor as to cause the teachers to complain to the Board of Education.

In an effort to improve the ventilation, ozone-producing apparatus was set up in the air passage between the air washer and the fan, and the air was recirculated. Just enough ozone was produced to be barely detected upon entering the building.

The result was entirely satisfactory. Every teacher in the building pronounced the ventilation perfect. Coughs and colds were noticeably less and no contagious disease developed during a six-weeks' trial, although influenza was epidemic at this time.

A second trial with equally satisfactory results followed in a school attended by colored children. A record of the weight of teachers and pupils taken at weekly intervals during the trial showed that about seventy-five per cent of the children gained in weight at the rate of one pound per week. Several fleshy children, weighing about one hundred and seventy-five pounds each, lost from five to eight pounds, and the principal, a man of about seventy years, weighing over two hundred, lost fifteen pounds during the several weeks' trial. Here again no contagious disease occurred, although the father and mother of two of the pupils died of influenza.

In summing up the results of these trials and of others under his observation, Mr. Hallett contended that ozone overcame the objectionable odors resulting from respiration and from the bodies and clothing; and that its use did away with the heating of outdoor air, thereby accomplishing a saving of about half of the coal bill. From the limited data collected, it appeared to prevent influenza and to be of value in improving the general health.

Naturally, all physiologists and ventilation engineers have not been willing to accept Mr. Hallett's findings as conclusive evidence. While all recognize the value of ozone as a deodorant, some have argued that any value it may have as a health tonic is a psychological one, brought about merely by its ability to mask objectionable odors. However, that may be, a live interest in the subject of ozone as an aid to ventilation has been awakened, and it is to be expected that much additional data and more accurate knowledge concerning the subject will soon be obtained.

Ozonators of both the stationary and portable types, of at least four makes, are now on the market and a considerable sale is being reported. The products of the four manufacturers are idential in principle, but vary in structural design and in the materials used.

In all of these ozonators, ozone is generated by the silent-brush discharge of a high-potential alternating current across a dielectric of glass, pyrex or some such material. Sufficient space is allowed for air to be drawn or blown through and become ozonized in its passage. The current consumption is comparatively small, only about 700 watts being consumed in ozonizing the air for a 24-room school building.

Tests are now being conducted in one of the public school buildings of Minneapolis under the supervision of the Research Bureau of the American Society of Heating and Ventilating Engineers, in which ozonized air is supplied to one of the class rooms and, for purposes of comparison, several similar rooms are each equipped with a separate ventilating system of one type or another. It is hoped that this work will contribute much to our knowledge of the subject of ventilation.

A certain engineering concern interested in the development of air-conditioning apparatus has for its slogan, "Every day a *good* day." Our health and mental ability and even our dispositions are influenced to a great extent by the nature of the air we breathe, and any advancement in a study of such vital concern as that of air conditioning should be a matter of interest not only to the physiologist and to the engineer, but to all mankind.

THE ONLY RESOURCE

The class in chemistry was wrestling with a tough problem.

"Suppose," supposed the professor, "you were called upon to attend a patient who had swallowed a heavy dose of oxalic acid—what would you administer?"

There was silence for a few moments and then a voice spoke up:

"The sacrament."—*American Legion Weekly.*